Sampling and Census 2000: The Concepts

Established statistical methods can reduce net undercounting of the population—if they are allowed

Ask anyone what the words "counting" and "sampling" mean in relation to a census. Nearly everyone will respond that a census is a "complete count" of a population and that different counts on different occasions would lead to the same (true) result, whereas sampling would lead to a different result only approximating the true one. Although counting is the most fundamental of mathematical operations and familiar to just about everyone, when it comes to the Census, counting turns out to be not quite as simple as "1, 2, 3."

Think of 10 people asked to count the number of persons at a local high-school basketball game during halftime. Assume all 10 are given the same instructions and are told to work independently from each other. During halftime, spectators come and go—some leave, some get refreshments, some switch seats—and the players and coaches go to the locker rooms. The ticket count will not do, because some are admitted without tickets, and some who bought tickets do not show. The dynamics of the population of persons in attendance at halftime suggest that some may be counted twice (those who change seats), and even more might be missed (those who were not in their seats when that area of the gym was being counted). If the 10 counters truly conduct their counting independently, the result will almost certainly be 10 different counts.

The fact that almost surely no two counters would get the same count or the *true count* is an illustration of *measurement error*. Just as the estimates of attendance at the basketball game contain measurement error, censuses of the United States contain measurement error (Mulry and Spencer 1991). With limited resources, it is difficult to employ methods that decrease measurement error in a census as large as that of the U.S. Although sampling techniques introduce *sampling error*, they offer the opportunity to diminish the larger measurement error and hence the overall error.

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Why Take the Census?

The Constitution gave Congress the responsibility to direct an enumeration of the population in each state every 10 years, with the primary purpose of providing a basis for apportioning congressional representation among the states. Most recently, that has meant taking a fixed number of 435 seats in the U.S. House of Representatives and distributing them among the states once every 10 years. In addition, census data are used today to draw congressional, state and local legislative districts, to allow population-based distribution of federal funds (over $150 billion annually) to the states and to provide all levels of government and private organizations with information to address many of our society's concerns from housing and health care to employment, education and transportation.

Continuing Challenges

Since the first Census of the United States in 1790, each decennial census has attempted to count each and every person in the country through direct contact. Yet even when Thomas Jefferson, who led the first census, reported the count, he noted that there was evidence suggesting that some persons had been missed (Alterman 1969). More recently, demographers have continued to provide evidence of missing people in each Census since 1940.

To estimate the population, demographers combine records basically using a simple equation:

$$\text{population} = \text{births} - \text{deaths} + \text{immigrants} - \text{emigrants}$$

There is evidence that the most recent decennial censuses have resulted in *net undercounting* of the population, which means that the undercounting is greater than the overcounting. And a great deal of concern centers on evidence suggesting that different subpopulations are undercounted at different rates—*differential net undercounting*. After the 1940 Census, the Bureau of the Census told the Selective Service how many young men it could expect to answer its call for the war effort. Three percent more men registered for the draft than had been counted. Among the African-American community, 13 percent more men showed up for registration than had been counted during the 1940 Census (Alterman 1969). For the 1990 Census, results from demographic analyses suggest that blacks had a net undercount of 5.7 percent, whereas nonblacks had a net undercount of 1.3 percent *(see Figure 2)*.

Extensive research conducted near the census-taking period in 1990 suggested some characteristics of the people who were missed, including complex housing arrangements (more than one family in a housing unit), informal housing arrangements (families in rented attics, basements, garages and trailers), mobile populations, fear of government and of census takers, and limited knowledge of English (de la Puente 1993).

In 1990, the Census Bureau produced two sets of numbers (each distributed among approximately 7 million blocks) for the population of the United States—one resulting from direct counting (248,709,873 people) and another that combined the results of direct counting with results from a scientific sample for a nationwide evaluation study (252,712,921 people). Meanwhile demographers produced a national-level estimate of 253,393,786. Comparing and analyzing the two sets of numbers with the national demographic estimate, the Census Bureau has concluded, for Census 2000, to have just one set of numbers, in which the final count results from an integration of *conventional counting techniques* (efforts to contact directly all housing units and all people) and *sampling techniques* (efforts to contact directly only a subset of housing units and / or people, that subset specified by probability).

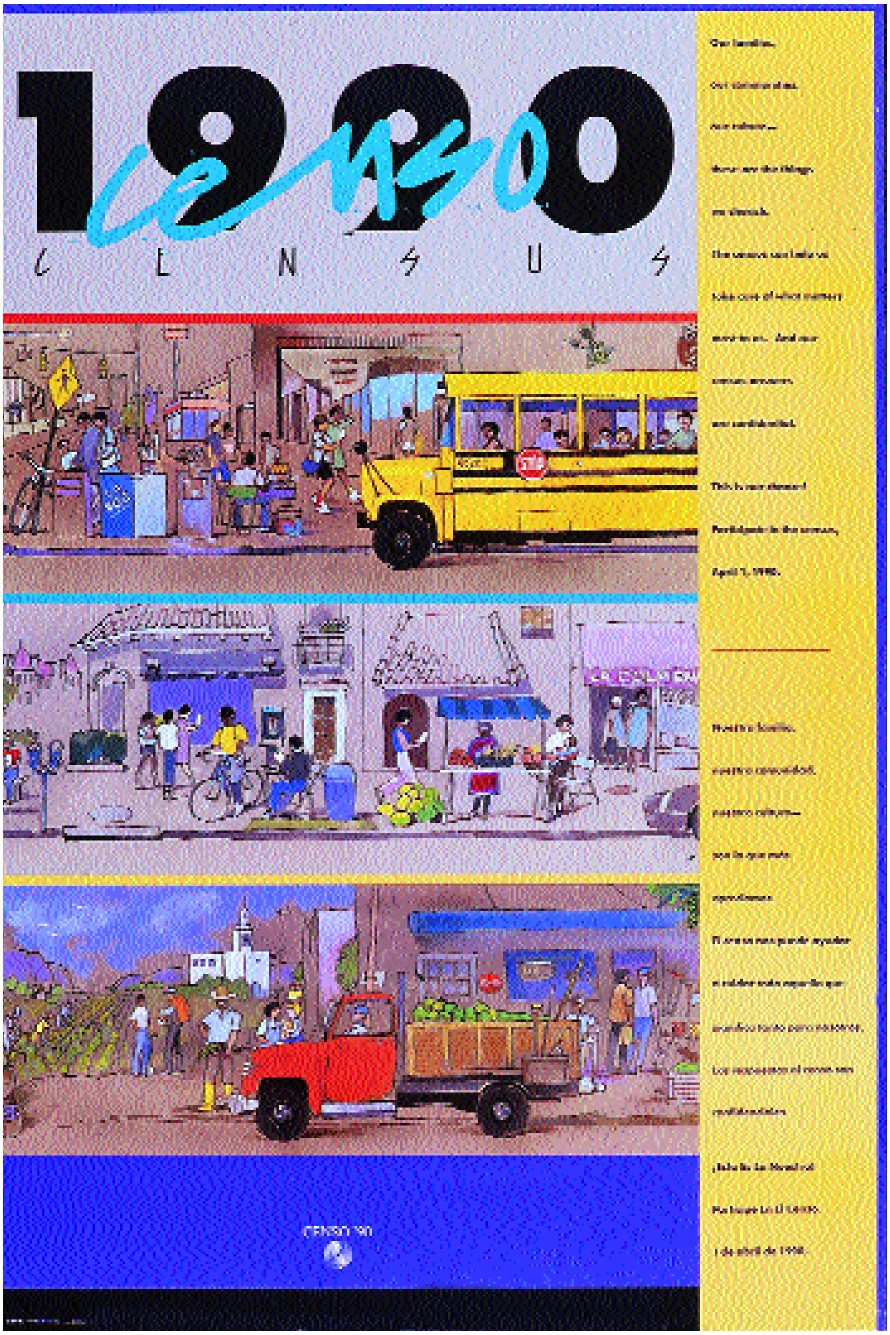

Figure 1. Like every United States census since the very first, the 1990 enumeration failed to fully count the population of the nation. Despite extraordinary efforts (such as publications in different languages, of which this poster is one example), the count—248,709,873—was estimated by the Bureau of the Census to fall more than 4 million short of the real number. For Census 2000, the Bureau of the Census proposes to combine conventional counting methods with probability sampling techniques—similar to the approach employed to determine error in the 1990 census—to reduce the net undercount of the population.

In this article I shall attempt to explain the concepts embodied in the Census Bureau's proposal to use sampling methods, combined with careful counting, to improve the accuracy of the decennial census. It should be understood that the Census 2000 plan has yet to be endorsed by Congress and, indeed, is meeting considerable opposition there. This article is intended to facilitate conversations about key statistical ingredients that will appear as part of the final plan, but it does not present the plan itself.

Conventional Counting in Census 2000

In the early phases, the Census 2000 plan calls for multiple improved conventional counting attempts to list every housing unit and to contact everyone directly.

To contact every address, the Bureau plans to develop a Master Address file, merging the 1990 Census Address List with a current national Postal Service list that is then updated quarterly. Local governments will be given opportunities to review and update the list. The result will be a national listing of nearly 120 million addresses. Before questionnaires are mailed to these addresses, Census Bureau employees will canvass every block to confirm address accuracy, knocking on doors to check and verify all addresses.

To count every person directly, extensive community outreach and paid advertising will then promote awareness of the upcoming census and participation by everyone. With an extensively tested mailing strategy, addresses will receive a prenotice letter, followed by an official census questionnaire, followed by a reminder / thank-you postcard. Consideration is being given to sending a replacement questionnaire to offer those who had not yet responded a second opportunity. In addition, a national "Be Counted" campaign will be directed at groups that historically have been undercounted. Easy-to-complete questionnaires in different languages will be made available in numerous public places, such as libraries and post offices.

Sampling in Census 2000

In each of the most recent censuses, questionnaires were mailed (some were hand-delivered) to every known residential address with a request to complete and return the questionnaires. In 1990, approximately 25.9 percent of the households did not do so. Approximately 500,000 persons were hired and trained as interviewers to go door-to-door to collect the required information from all of the nonrespondents. This process was difficult, jeopardized data quality and was time-consuming. Following up on all nonresponding households is also very expensive. Indeed, in some cases, information had to be obtained from neighbors.

By contrast, the Census 2000 Plan proposes to follow up on a sample of nonresponding households and use statistical methods to estimate the characteristics of the remaining nonresponding housing units. It is hoped that this approach will improve timeliness and data quality and control costs. The sample will be selected to ensure direct response from at least 90 percent of the housing units in each census tract and to estimate the number of persons in any remaining nonresponding units. This is called *sampling for a follow-up of nonresponding housing units.*

Even after follow-up, whether on a 100-percent or a sampling basis, there will still be persons who are missed or incorrectly enumerated in the responding housing units, as well as persons missed who live in households that were probably missed and may not have been included in the Census Bureau's master-address file. Thus a nationwide probability sample of approximately 25,000 blocks (approximately 750,000 housing units) will be selected for a quality check to improve the final count. This will improve the overall coverage, and, in particular, the differential net undercounting will be reduced. This is called *sampling for a quality check for coverage improvement.*

Although not the focus of this article, there are other planned uses of sampling in Census 2000: a nationwide sample of one-sixth of the addresses will be asked to provide legally required data beyond those needed for the count; a nationwide sample of housing units declared vacant by the U.S. Postal Service will be selected for personal visits to estimate the true number of vacant units; and periodic samples will be selected at various quality-assurance checkpoints to ensure the continued proper operation of the Census 2000 process as planned.

Integration of Two Measures

The Census 2000 plan is unprecedented in that it will obtain and integrate two measures of the population to obtain a "one-number census." The *first measure* will include counts from conventional counting techniques (listing, mailbacks, counts received by telephone, ''Be Counted'' forms and so on), follow-up sampling and statistical estimation. In a hypothetical census tract of 15 blocks with approximately 4,000 people in 1,500 housing units, we might assume that conventional counting methods applied everywhere result in 1,005 (or 67 percent) responding housing units. To ensure direct contact with at least 90 percent of the units in each tract, we would, using randomization, select 345 of the 495 nonresponding units for visits and interviews. Responses for the 150 (10 percent) remaining housing units would be estimated using sample interview data from the sample of 345 housing units.

The *second measure* will come from the nationwide probability sample of approximately 25,000 blocks mentioned above. This sample is totally independent of the data from the first measure; in fact, the sample is selected before the data in the first measure are taken. Census workers will knock on the door of each housing unit in the sample blocks and list every person who was a resident on Census Day—

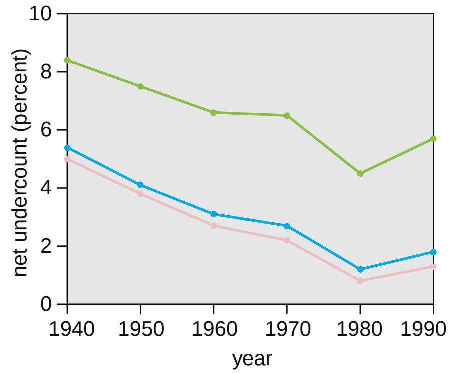

Figure 2. Based on demographic analyses, net undercounting of the U.S. population *(blue)* declined steadily from 1940 to 1980 but rose in 1990. At least as troubling, the net undercount of minorities such as blacks *(green)* remained several times higher than that of nonblacks *(red)* and may be increasing at a greater rate.

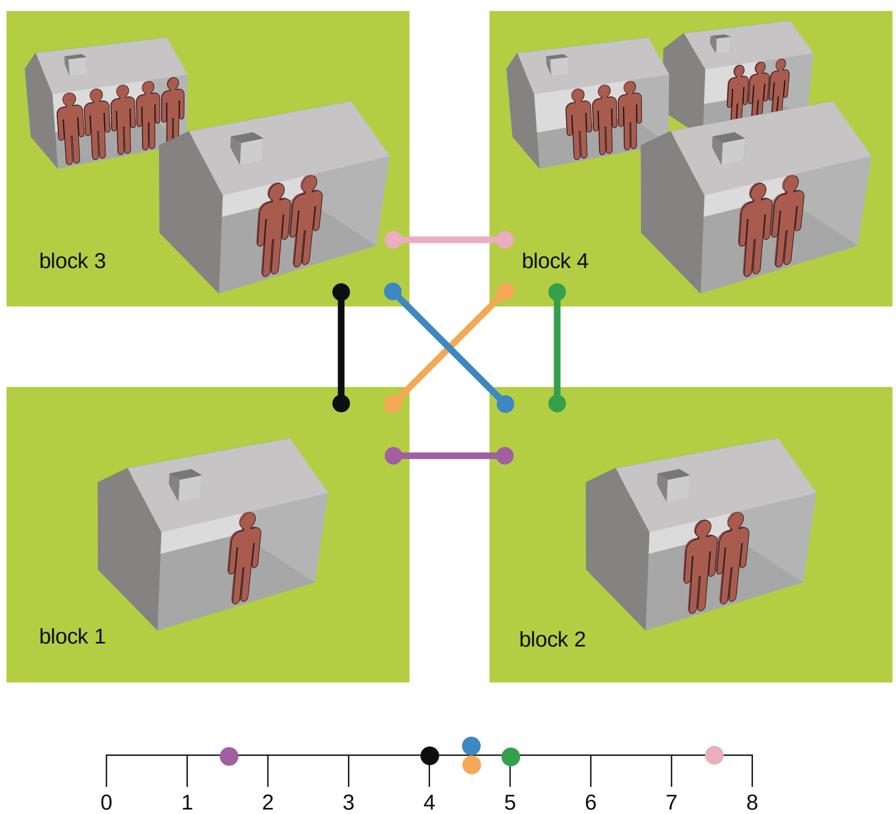

Figure 3. In this hypothetical example of simple random sampling, with a sample size of two, the variation in sample average estimates is quite high: from 1.5 to 7.5. (Bars connecting housing units designate the six possible samples and correspond to the estimates on the bar below.)

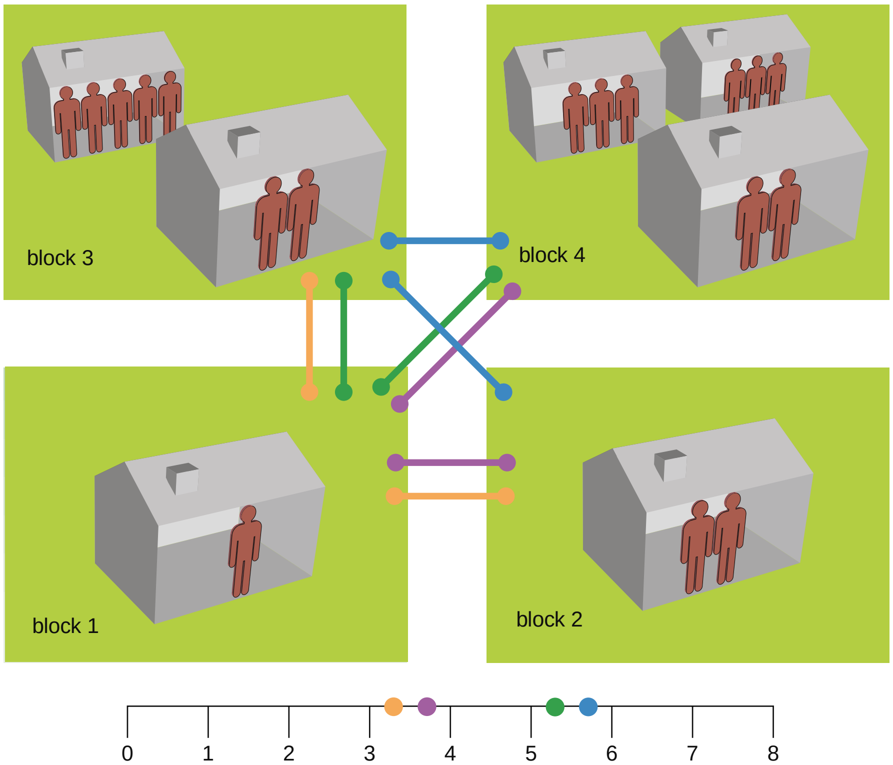

Figure 4. Under simple random sampling, variation in sample average estimates can be reduced by *increasing the sample size.* **Increasing the sample size to three of four blocks reduces variation to from 3.33 to 5.66. Unfortunately, the costs of increasing sample size can be significant.**

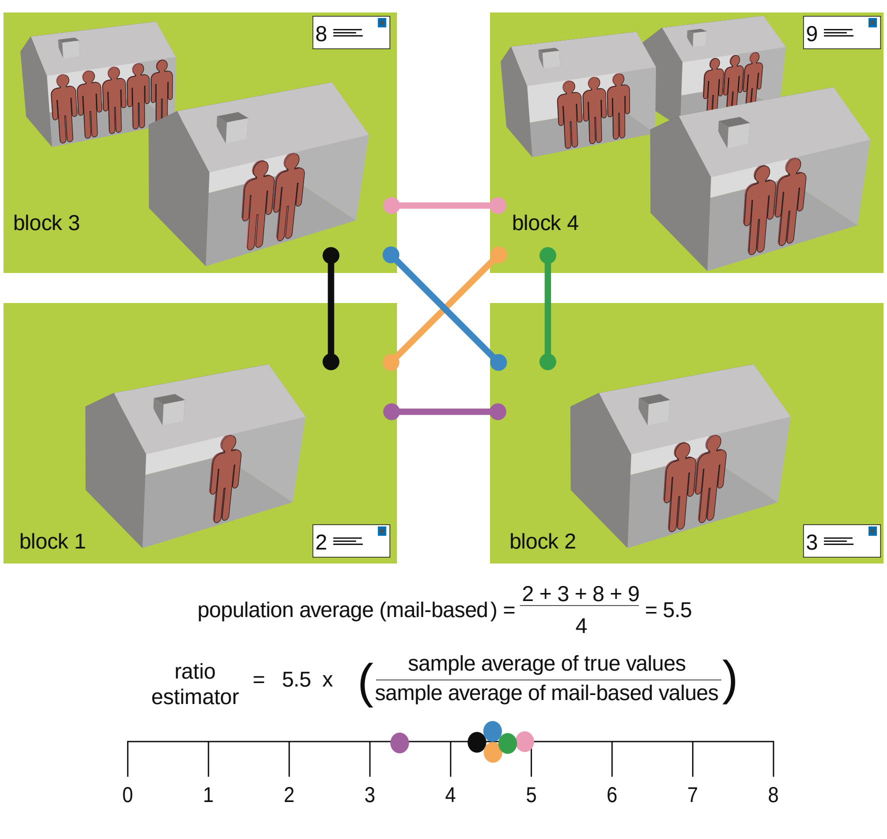

Figure 5. Under simple random sampling, *ratio estimation* **seeks to reduce sampling variation by using known characteristics of the population. In this example, known postal records (although not perfect) of delivery to blocks are used with sample data from two blocks. The result dramatically reduces variation among the sample estimates: from 3.30 to approximately 4.85.**

again, without reference to earlier collected information.

For each of these 25,000 sample blocks, the Census Bureau will compare the first measure with the independent second measure, looking for matches of housing units and persons. Next, these two measures will be combined to yield a single set of counts for all areas in the nation. Specifically, the concept is to multiply the first measure (mostly based on counting) by the second measure (based on sampling) and divide this product by the number of matches, leading to an improved count—the *one-number census.*

What Is Sampling?

Practically every day we pick up the newspaper, tune into a news broadcast or surf the Internet and are bombarded with data, much of it made possible by an area of statistics referred to as scientific probability sampling, or simply sampling (Cochran 1977).

The American Statistical Association's *What Is Sampling* (1980) describes sampling in this way:

> ... we gather information from only a small sample.... In a bonafide survey, the sample is not selected haphazardly or only from persons who volunteer to participate. It is scientifically chosen so that each individual in the population has a known chance (probability) of selection. In this way, the results can be reliably projected to the larger [population]....

W. E. Deming (1978), an internationally known statistician and quality expert who was involved in early sampling-related work at the Bureau of the Census and who taught Japan the power of statistical methods in producing quality products starting the early 1950s, put the nature of sampling quite concisely:

> It is [not] ridiculous to think that one can determine anything about a population of [more than 250] million people, or even 1 million people, from a sample of a few thousand. The number of people in the country bears almost no relationship to the size of the sample required to reach a prescribed precision. Consider a jar of black and white beans. If the beans are really mixed, a cupful would determine pretty accurately the proportion of beans that are black. The cup-

ful would still suffice and would give the same precision for a whole carload of beans, provided the beans in the carload were thoroughly mixed. The problem lies in mixing the beans. The statistician accomplishes mixing by the use of random numbers.

To Sample or Not To Sample

As F. F. Stephan noted in 1948, the ‘‘common practice of taking a small part or portion for tasting or testing to determine the characteristics of the whole precedes written history.’’ Historically, however, the application of sampling techniques has had its ups and downs, largely owing to common misconceptions about sampling.

The heart of these misconceptions seems to be a belief that if one wants to know something about a given population, it is better to contact the entire population (a census) rather than only a sample of the population. However, many data collectors realize that large data sets can contain a large number of errors. It is often preferable to use resources and funds to develop a well-designed smaller-scale sample survey where high-quality data can be collected from a few. Modern statistical methods can be used to extend results from the sample to the entire population (Lessler and Kalsbeek 1992, Wright 1983).

As Leslie Kish (1979) has pointed out, censuses, if done correctly, have the potential advantage of providing precise, detailed and credible information on all population units. On the other hand, samples have the advantage of providing richer, more complex, accurate, inexpensive and timely information for a smaller portion of the population units. By making use of sampling methods in a census context, it is hoped that we can realize the advantages of both methodologies.

Some ABCs of Sampling

For the purpose of exploring how sampling works, let us say that we want to know about a four-block area. In this area block 1 has 1 person, block 2 has 2 persons, block 3 has 7 persons and block 4 has 8 persons. The average population per block is 4.5 persons. Now assume that this average is unknown, and we want to know it.

Because of limited resources one can usually only contact a sample of the population. By considering different approaches that illustrate the ability of sampling techniques to reduce variability, we shall select a more manageable sample of two blocks from the four blocks and compute estimates of the population average per block.

As Figure 3 illustrates, there are six possible samples of two blocks each that can be selected from the group of four blocks. If each sample has an equal probability of being selected, the method of sampling is called *simple random sampling*.

As shown in Figure 3, with simple random sampling these samples provide a wide range of *sample average estimates*. If we select blocks 1 and 2 for the sample, we estimate an average of 1.5. The answers are very different for other samples. The fact that the estimates range from 1.5 to 7.5 persons per block reflects *sampling error*, error resulting from the fact that the estimate is based on the sample and not the entire population.

Is it possible to use sampling and statistical methods that would not yield such extreme estimates as 1.5 and 7.5? We would like assurance that just about all possible estimates vary by a small amount from the true average, 4.5. The answer lies partly in mathematical techniques that can be employed to decrease the variability of our estimator. These include *increasing* the sample size, estimating using *ratios* effectively and *stratifying*—grouping like units of the population before selecting the sample.

First we could increase sample size, as illustrated in Figure 4, where we apply simple random sampling with a sample of size three blocks. The variability of the estimator is reduced significantly—to a range of 3.33 to 5.66 persons per block—but the cost rises.

Despite its intuitive appeal, increasing sample size can be the least effective (as well as the least economical) of the techniques available to reduce variability. We move on to evaluate the second method, *estimating using ratios effectively*. Here we make use of prior information.

Suppose that one piece of information that is known is the number of persons associated with a block based on observed ‘‘distinct’’ names appearing on all mail delivered to the block over a period of time. The true number of persons associated with that block is unknown.

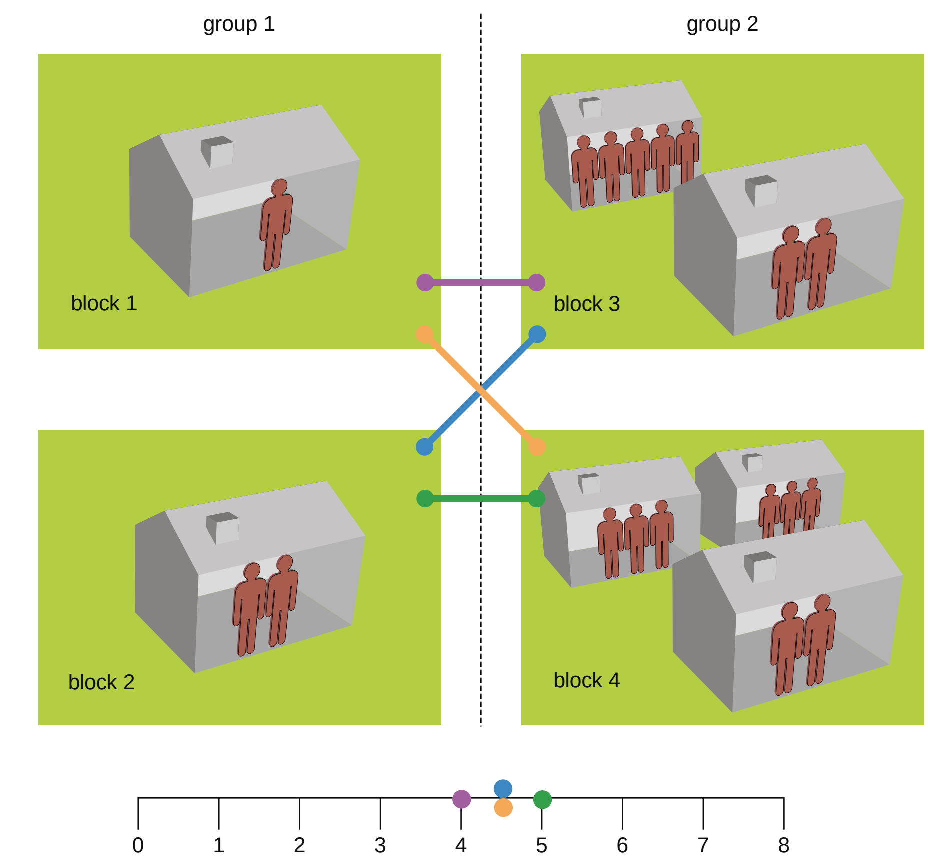

Figure 6. Under stratified random sampling, *stratification* seeks to group blocks with similar characteristics and samples from among the groups. By grouping the blocks in the example population according to known mail-based records, the number of possible samples of size two is limited to four, and the variation is reduced to from 4 to 5.

Figure 7. Households from five Alabama blocks in the 1990 census provide an example of how sampling can improve conventional counting results. Suppose the goal is to determine the number of white, non-Hispanic persons at least 18 years of age. The top panel shows the true population, which, of course, is unknown. The second panel shows the results of conventional counting methods. In the third panel, census-takers are sent to knock on the doors of two (chosen by randomization) of the three households that failed to respond to the questionnaires. They find two persons of interest, raising the total count to nine. In the bottom panel, statisticians estimate that the other (nonsampled) non-responding household has one white, non-Hispanic person at least 18 years old. Thus the total count for this *first measure* is 10.

We can use the known information to refine our estimate of the average number of persons per block. This is done by taking the population average of the distinct names on mail, or “mail-based values,” and multiplying this average by a ratio. This ratio is the sample average of the true values divided by the sample average of the mail-based values. This is called *ratio estimation*.

Suppose the mail-based results for blocks 1 through 4 are 2, 3, 8 and 9, respectively. The mail-based population average is the average of these counts, or 5.5.

We use this number to obtain ratio estimates. If we select blocks 1 and 2 for the sample, we obtain by house-to-house counting a sample average value of 1.5; the mail-based sample average is 2.5. The value of the ratio estimator in this case is 5.5 x (1.5/2.5), or 3.3. Working through the six samples, we derive ratio estimates of 3.3, 4.4, 4.5, 4.5, 4.58 and 4.85. We have reduced variability to 3.3 to 4.85 persons per block with minimal additional cost *(see Figure 5)*.

We also can reduce variability of the estimate of average population per block by grouping, or stratifying, blocks based on known similar characteristics before we select the sample. Again we are making use of prior information. For example, we can group the two blocks with small known mail-based values from Figure 5 (1 and 2) into one group together and the two blocks with larger mail-based values (3 and 4) into another. We assume that this will result in the grouping of true values that are similar, because we assume a close relation between mail-based values and true values. Then we randomly select one block from group 1 and independently randomly select one block from group 2. This is called *stratified random sampling*. Using this method, we have only four possible samples, and the variability is reduced to 4.0 to 5.0 persons per block, as shown in Figure 6. The overall sample size is still 2 blocks.

The result of these illustrations will be surprising to many. Increasing sample size does not always yield the best results. The Census 2000 plan aims to make effective use of ratio estimation and stratification to yield more reliable results.

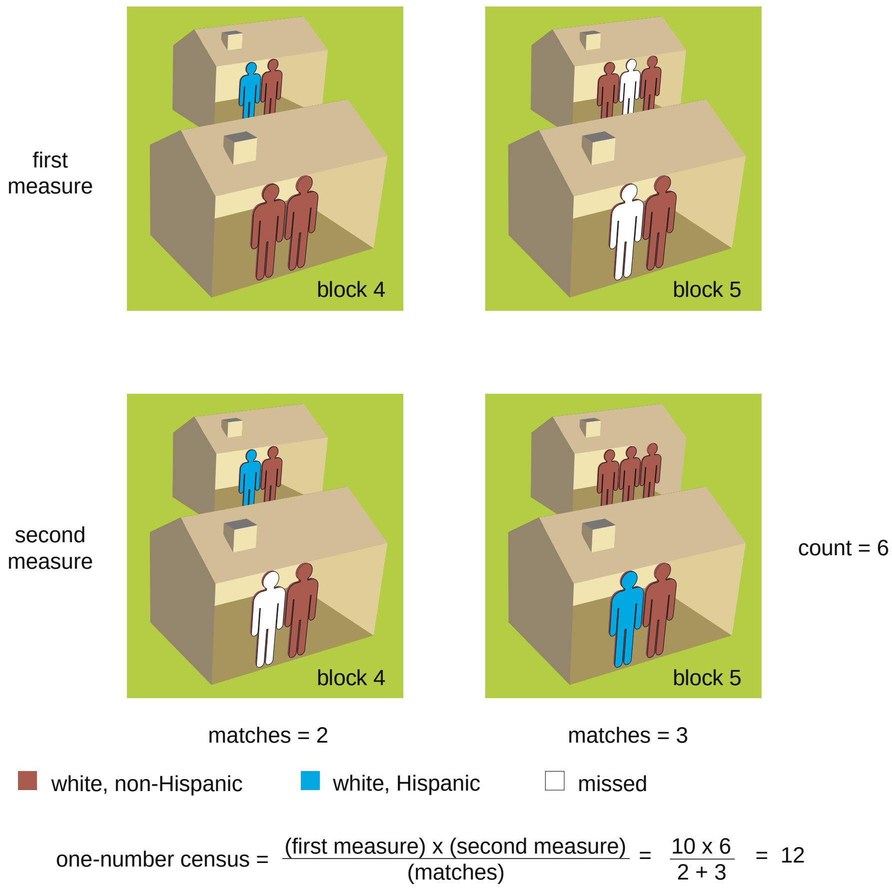

Figure 8. *Second measure* **involves selecting (with randomization) two blocks to be measured completely independent from the first measure—here blocks 4 and 5. The matches between the first and second measures are obtained, and that number as well as the total counts from the two measures are analyzed using** *dual-system estimation* **to yield a** *one-number census.* **This example produces the correct result, although not all samples would. Nonetheless, the technique significantly reduces variation and has been demonstrated to produce a more accurate result than conventional counting alone.**

Simulation of the Census 2000 Plan

Using 1990 Census data for a group of five similar blocks in Alabama, I attempt to explain on a small scale how sampling techniques can be used to supplement and improve results from conventional counting techniques. All persons in this group of blocks are white. Some persons (indicated by blue in Figure 7) are also of Hispanic origin. To illustrate how the basic concepts would be applied to different person types, we focus only on one person type (white, non-Hispanic, at least 18 years of age) and ignore all others. By inspection, there are 12 such persons depicted in the top panel of Figure 7. We assume this true count of 12 is initially unknown.

What follows illustrates how the Census Bureau might proceed to determine this unknown number of persons using major components of the Census 2000 plan when there is the possibility of undercounting error. (For simplicity we assume no other types of error are possible.)

Suppose that conventional counting of these five blocks results in 3 nonresponding housing units and 1 missed person in a responding housing unit. In the second panel we see that following mailbacks, the count in the five blocks is 7.

Next, we select a sample of two of the three nonresponding households for door-to-door visits and interviews—the front housing unit in block 2 and the back in block 3. Going to the selected housing units and enumerating the persons associated with them, we find that each has one white, non-Hispanic person at least 18 years old. However, there is still one person in the back house in block 3 who is not reported *(see panel 3, Figure 7)*. Having seen 2 persons of interest in the sample of two nonresponding housing units, one statistical estimate would be that there are a total of 3 persons of interest in all three nonresponding housing units. The total estimate now is 7 persons identified by conventional counting, plus 2 from follow-up sampling

	those in second measure	those not in second measure
those in first measure	N_{11}	N_{10}
those not in first measure	N_{01}	N_{00}

Figure 9. Dual-system estimation has easily understood mathematical roots based on algebraic manipulation of four groups of persons found in one, the other, both or neither of the measures.

interviews, plus 1 from statistical estimation *(bottom panel, Figure 7).* This is what is called the *first measure.*

If we were to stop at this point, our measure would be short two persons. We proceed to the second measure. Assume that we select two blocks for a quality-check sample. We send into the field our best enumerators to do a complete independent second measure of these blocks. Even with this operation, we know there is a chance that some persons might be missed. As illustrated in Figure 8, assume we select blocks 4 and 5, where the result from the second measure is 2 + 4 = 6 persons.

Focusing only on white, non-Hispanic persons at least 18 years of age, we compare the two measures for blocks 4 and 5. From Figure 8, the number of matches are 2 persons in block 4 and 3 persons in block 5, for a total of 5 matches. For our particular person type, the result, using dual-system estimation, is the one-number census:

$$\begin{pmatrix}\text{one}\\ \text{number}\\ \text{census}\end{pmatrix} = \frac{\begin{pmatrix}\text{first}\\ \text{measure}\\ \text{(counting)}\end{pmatrix}\begin{pmatrix}\text{second}\\ \text{measure}\\ \text{(sampling)}\end{pmatrix}}{\text{(matches)}}$$

or $(10 \times 6)/5 = 12$. Hence the results from the two measures have, in this case, been successfully integrated into a single measure of the population. In this example there are many possible results and ways to arrive at them, some less than 12, some equal to 12 and some greater than 12. But on average, theory and research show that the one-number census count would be right at 12.

Dual System Estimation

Dual System Estimation is the name used by the Census Bureau to describe the formula that combines the first measure with the second measure. It is a variation of a statistical method, called *capture-recapture,* that has been in use at least since 1896, when C. G. J. Petersen studied the immigration of a type of flounder into a fjord. Other early references include Schnabel (1938), Chapman (1948), and Sekar and Deming (1949). S. E. Fienberg (1992) "… presents a selected annotated bibliography … [including] the application of these techniques in the context of census undercount estimates." An account of an application of the methodology to evaluate the result of the 1990 Census of the United States is given by H. Hogan (1992). In a Monte Carlo study with L. Bates (1996), we found that the formula had a remarkable ability to ultimately provide estimates that are, on average, extremely near the truth when there is the possibility of undercounting with both the first and *second measures*.

The formula has an elementary derivation. Assume that two independent measures (the first and second measures) are made of a population of N people expressed as

$$N = N_{11} + N_{10} + N_{01} + N_{00}$$

where N_{11} is the number of persons listed on both occasions (the matches), N_{10} is the number listed on the first occasion but not the second, N_{01} is the number of persons listed on the second occasion but not the first, and N_{00} is the number listed on neither occasion. These counts are often displayed in a 2×2 layout as shown in Figure 9. Clearly, everyone in the population is accounted for.

Following both surveys, the counts N_{11}, N_{10} and N_{01} are known, whereas N_{00} is unknown. Because the measures were independently collected, and assuming that for each effort each individual has the same probability of being listed, the probability of an individual being listed both times is the product of the probability of being in the first measure and the probability of being in the second measure, or, equivalently:

$$\frac{N_{11}}{N_{11}+N_{10}+N_{01}+N_{00}}$$
$$= \frac{N_{11}+N_{10}}{N_{11}+N_{10}+N_{01}+N_{00}}$$
$$\times \frac{N_{11}+N_{01}}{N_{11}+N_{10}+N_{01}+N_{00}}$$

Solving algebraically for N_{00} provides an estimator $\widehat{N}_{00}$:

$$\widehat{N}_{00} = \frac{N_{10} \times N_{01}}{N_{11}}$$

Thus the unknown value of N is estimated by:

$$\widehat{N} = N_{11} + N_{10} + N_{01} + \widehat{N}_{00}$$
$$= \frac{(N_{11}+N_{10}) \times (N_{11}+N_{01})}{N_{11}}$$
$$= \frac{\text{(first measure)} \times \text{(second measure)}}{\text{(matches)}}$$

It is worth noting that this estimator is a type of ratio estimator where the ratio is the quotient of "second measure" divided by "matches." Ratio estimation was used for estimating the population of England as early as 1662 by John Graunt, and Laplace later used the same method to estimate the population of France as of September 22, 1802 (Cochran 1978).

Returning to the simulation with the five Alabama blocks, we notice that $N_{11} = 5$, $N_{10} = 5$ and $N_{01} = 1$.

For the five blocks, only including those persons reached through the first measure, we would report that there are 10 persons (N_{11} + N_{10}). Using the first measure and the second measure, but not applying the formula, we would report that there are 11 persons ($N_{11} + N_{10} + N_{01}$), one too few. The distribution of the 11 persons among the 5 blocks would very likely be respectively: 0, 3, 1, 3, 4. In a very elegant way, the capture-recapture model gives us a way to include the person missed by both measures. For the possibility presented, the formula tells us that there are 12 persons of the particular type that is of interest.

The Compromise

It is well established that the magnitude of measurement error can far exceed that of sampling error. With the Census 2000 plan, the Census Bureau believes that sampling helps improve overall counting, helps decrease differential net undercounting and helps control costs. Methods used in the past—including partnerships, outreach, promotion and advertising—have not adequately addressed the net undercounting. If only the conventional counting methods of the past are used, the Census Bureau will be strained to obtain sufficient funding, time and the necessary numbers of people to do proper follow-up and checking.

Nonetheless, not all favor the use of sampling methods, as sketched in this article, in Census 2000. The different points of view were brought to the public's attention during the debate over the federal budget for fiscal year 1998. Although it seems to recognize the advantages of sampling, Congress expressed concern about the constitutionality of sampling, the possibility that the use of statistical methods would allow the data to be manipulated for political advantage and, finally, the magnitude of sampling error in very small geographical areas (that is, at the block level).

The Census Bureau had planned to carry out a "dress rehearsal" of the Census Plan 2000 in Sacramento, California, 11 counties in the Columbia, South Carolina area, and the Menominee Reservation in Wisconsin. This demonstration would have included sampling at all three dress-rehearsal sites. Congress objected and insisted on a dress rehearsal without sampling being used to produce the final counts. Almost two months into the 1998 fiscal year, on November 26, 1997, President Clinton signed a compromise appropriations bill that included funding for the dress rehearsal. The bill permits sampling in Sacramento (and Menominee) but not in South Carolina.

The compromise allowed the Census Bureau to continue planning and executing the dress rehearsal in preparation for Census 2000. In early 1999 and at the conclusion of the dress rehearsal, Congress will provide further guidance to the Census Bureau on how to conduct Census 2000. Stay tuned.

Acknowledgment

This article is dedicated to Martha Farnsworth Riche, former director of the Census Bureau, who courageously argued in favor of the Census 2000 plan.

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Links to Internet resources for further exploration of "Sampling and Census 2000: The Concepts" are available on the *American Scientist* Web site:

http://www.amsci.org/amsci/articles/98articles/wright.html